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(71) Applicant: ASAHI DENKA KOGYO KABUSHIKI KAISHA
2-35, 7-chome Higashiogu
Arakawa-ku Tokyo 116(JP)

(72) Inventor: Shirakawa, Yoichi
22-14, Motomachi 3-chome
Urawa-shi Saitama(JP)
Inventor: Minowa, Yoshio
392-26, Sanukimachi
Ryugasaki-shi Ibaraki(JP)
Inventor: Azumi, Takayoshi
150-6, Ohya
Ohmiya-shi Saitama(JP)
Inventor: Hisano, Junichi
15-41-403, Kitaurawa 5-chome
Urawa-shi Saitama(JP)

(74) Representative: Taylor, Phillip Kenneth et al
W.P. THOMPSON & CO. Coopers Building
Church Street
Liverpool L1 3AB(GB)

(54) Process for producing protein-rich fish meal and/or fish oil.

(57) A process for producing a protein-rich fish meal and/or fish oil which comprises treating fish with a protease acting at a relatively low temperature to give a slurry and dividing and drying said slurry at a relatively low temperature. The products thus obtained undergo very little thermal denaturation but contain a large amount of partially enzymatically decomposed protein. Thus they are highly useful as a protein source for, e.g. feeds, baits and pet foods.

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"PROCESS FOR PRODUCING PROTEIN-RICH FISH MEAL AND/OR FISH OIL."

This invention relates to a process for producing a fish meal and a fish oil. More particularly, it relates to a process for producing a fish meal and a fish oil scarcely undergoing thermal denaturation, which comprises treating fish bodies with a protease at a relatively low temperature and dividing and drying the treated matters each at a relatively low temperature.

This invention further relates to a process for producing a protein-rich fish meal suitable as a protein source for, e.g., feeds, baits and pet foods. More particularly, it relates to a process for producing a fish meal which contains a small amount of ash as well as a large amount of partially decomposed and scarcely denatured crude protein.

Fish meal and fish oil have been produced from fish bodies and processing residue thereof by optionally pretreating, for example, cutting, crushing or grinding the raw material; boiling the treated material; pressing the same to thereby separate liquid matters containing a fish oil;
drying the residual solid matters optionally together with fish-solubles, which will be described hereinafter; grinding the material, if required, to thereby give a fish meal; while separating the fish oil from the liquid matters; and concentrating the residual liquid matters to thereby give fish-solubles.

Since the abovementioned process involves high temperature heating processe(s) such as boiling, proteins contained in the fish meal thus obtained are thermally denatured ones, which makes the product not always satisfactory as a proteinous feed.

In addition, the fish oil as produced by the above process is also a thermally denatured one. Thus it is difficult to thereby obtain a fish oil of excellent qualities.

A known method of producing a crude protein-rich fish meal employs white-meat fish rich in crude protein as the starting material. However the sources of such material are limited and the material itself is expensive so that development on a large scale is not possible.

In order to overcome these problems, Japanese Patent Laid-Open No. 156370/1985 has proposed a process wherein a conventional fish meal is divided into a portion rich in fish bones (i.e. ash) and another portion containing a small amount of the same. However the fish bone-rich portion still contains a significantly large amount of protein. Thus this process is unsatisfactory from the viewpoint of the effective utilization of protein.

The conventional processes for producing fish meal involve high-temperature heating step(s) such as boiling. Thus the obtained fish meal is a thermally denatured one, which sometimes makes it unsatisfactory as a protein source for feeds, baits or pet foods.

A process which converts into fish protein in the form of a fish meal or fish oil similar to those obtained by a conventional method in which the conditions of treatment cause little thermal denaturation would be highly desirable.

It has now unexpectedly been found that a slurry can be obtained at an early stage by treating fish bodies with a protease acting at a relatively low temperature and that the obtained slurry can be divided into a cake, a heavy liquor and a light liquor on a three-phase decanter.

It has further been found that fish meat can be readily removed from fish bones at an early stage by treating fish bodies with a protease acting at a relatively low temperature to thereby give a slurry; that fish bones almost free from fish meat can be obtained by sieving said slurry; and that the slurry free from the fish bones can be readily divided into solid and liquid matters by using a continuous decanter.

According to the present invention a process is provided for producing a fish meal and/or a fish oil from fish bodies in which the fish bodies are treated to separate solid and liquid portions therefrom and the separated portions further treated to produce fish meal and/or fish oil, characterised in that the fish bodies are treated with a protease at a temperature at which the protease is active to form a slurry and the slurry is separated into solid and liquid fractions by means of a continuous decanter.

In one embodiment of the process of the present invention a crude protein-rich fish meal is produced by treating fish bodies, which have been optionally cut, with a protease at a temperature at which the protease is active to thereby give a slurry; sieving said slurry to thereby remove fish bones; dividing the slurry free from the fish bones into solid and liquid matters by using a continuous decanter such as a two-phase decanter; drying the solid matters optionally together with fish-solubles, which are prepared by continuously centrifuging the above-mentioned liquid matters and concentrating the stick water thus obtained, to thereby give a crude protein-rich fish meal.

A preferred embodiment of the process of the present invention produces a fish meal and a fish oil.

First, the starting material, i.e., fish which have been optionally cut, is treated with a protease in a continuous or batch-wise reactor provided with a stirrer at a temperature at which the protease is active for

30 minutes to one hour, preferably for 40 to 50 minutes, under stirring. At this step, 0.001 to 1.0% by weight, based on the material to be treated, of the enzyme may be used.

The slurry thus obtained is separated in a continuous three-phase decanter into a cake, a heavy liquor and a light liquor mostly comprising fish oil. The heavy liquor is then concentrated at a temperature below 80°C preferably below 75°C, and the resulting concentrate is combined with the abovementioned cake. The mixture of cake and concentrate is fed into a dryer and dried therein at a temperature below 80°C, preferably below 75°C and then ground, if required, to thereby give a fish meal. Separately, the light liquor is continuously centrifuged to separate the fish oil therefrom.

Examples of the fish bodies to be used as the starting material in the process of the present invention include fishes which are caught in large quantities, such as herring, sardine, mackerel, saury, round herring, Alaska pollack, flatfish, anchovy and pilchard. In order to produce a fish meal and a fish oil of excellent qualities, it is desirable to employ fresh fish.

Examples of the protease to be used in the present invention include proteinases such as acrosin, urokinase, uropepsin, elastase, enteropeptidase, cathepsin, kallikrein, kiniase 2, chymotrypsin, chymopapain, collagenase, streptokinase, subtilisin, thermolysin, trypsin, thrombin, papain, pancreatopeptidase and rennin; peptidases such as aminopeptidases, for example, arginine aminopeptidase, oxytocinase and leucine aminopeptidase; angiotensinase, angiotensin converting enzyme, insulinase, carboxypeptidase, for example, arginine carboxypeptidase, kiniase 1 and thyroid peptidase, dipeptidases, for example, carnosinase and prolinase and pronases; as well as other proteases, denatured products thereof and compositions thereof. These proteases may be classified into exopeptidases acting from the end of a polypeptide chain and endopeptidases acting inside thereof depending on the mode of their actions, and the latter is preferable. The protease is preferably one which is active at a temperature in the range of 30°C - 80°C preferably at 45°C to 75°C.

A situation whether in a continuous or batch-wise reactor, may be effected in such a manner as to sufficiently contact the fish being treated with the protease. When a continuous reactor is to be used, it is preferable that the slurry is in the form of an extruded flow. In order to achieve this, a horizontal reactor may be employed. When a batch-wise reactor is to be used, on the other hand, either a conventional tank-type reactor or a horizontal one may be used.

In the conventional production of fish meal and fish oil, a screw press is commonly employed for the separation of solid and liquid matters. However this procedure cannot be employed unless the protein has been coagulated by heating, for example, boiling. This procedure, which is accompanied by the leakage of a large amount of solid matter into the liquid portion, cannot be employed in the process of the present invention. Various procedures have been examined for achieving the separation and it has now been found that the use of a continuous decanter such as in two-phase or a three-phase decanter is highly effective therefor.

Examples of available continuous decanters are three-phase decanters of the KVZ-T series (mfd. by Mitsubishi Kakoki Kaisha, Ltd) and two-phase decanters of the shear Press Super-Decanter P series (mfd. by Tomoe Kogyo K.K).

The heavy liquor is concentrated in order to improve the state of mixing of the same with the cake and to lower the production cost. When unconcentrated heavy liquor is combined with the cake, the resulting mixture is in the form of a slurry, which makes the subsequent drying difficult. From the viewpoint of heat efficiency, too, concentrating the heavy liquor in a concentrating drum is preferred to evaporating the moisture in a dryer. The concentration should preferably be carried out only to the extent that the resulting concentrate is still sufficiently flowable, for example by lowering the moisture content of the heavy liquor to approximately 70%.

The fish meal as produced by the process of the present invention has undergone thermal denaturation only to a slight extent, since the process of the invention does not require a high-temperature heating step such as boiling. Further the protein contained in the fish meal produced according to the invention is partially decomposed by enzymatic action, which promotes the absorption and digestion thereof. Thus the fish meal produced by the method of the invention is highly desirable as a protein source for, e.g., fish feeds and pet foods.

The fish oil as produced by the process of the present invention contains valuable trace components which have not been thermally denatured. In addition, it may be used as an excellent edible oil by treating in a conventional manner, e.g., refining, deodorizing or hydrogenating.

The process of the present invention provides a fish meal and a fish oil, which are superior in quality to those produced by conventional processes and with a yield comparable to that of a conventional process.

Fish meal has been employed as the main protein source of, for example, feeds, baits and pet foods. A crude protein-rich fish meal is particularly requisite for, e.g., fry feeds in order to elevate the feed efficiency.

The fish meal as produced by the process of the present invention is advantageous not only in that it is rich in crude protein but also in that the protein contained therein is hardly thermally denatured but is partially enzymatically decomposed and thus highly digestive and absorbable. Thus the fish meal is excellent as a protein source for, e.g., feeds, baits and pet foods.

In producing a crude protein rich fish meal from fish, the fish which have been optionally cut, are treated with a protease with continuous agitation in a reactor at a temperature at which the protease is active and within the range of 30 to 80 °C, preferably at 45 to 75 °C, for 30 minutes to one hour, preferably for 40 to 50 minutes.

The enzyme may be employed in an amount of 0.001 to 1.0 % by weight based on the material to be treated.

The slurry thus obtained is passed through a 1 to 30 mm-mesh, preferably 5 to 15 mm-mesh sieve to thereby remove fish bones therefrom. It is preferable to pass the slurry through the sieve together with a small amount of water to thereby promote the remove of fish meat from fish bones, thus improving the yield. After removing the fish bones, the slurry is fed into a continuous decanter e.g. a two-phase decanter and divided into solid and liquid fractions. The solid matter is fed into a dryer optionally together with fish-solubles, which are obtained by continuously centrifuging the liquid matter as obtained above to remove stick water and then concentrating the stick water at a temperature below 80 °C preferably below 75 °C, and then the mixture of solid fraction and fish-solubles dried at a temperature below 80 °C, preferably below 75 °C. The dried product may be ground, if required, to give a fish meal.

Examples of continuous centrifuges which may be used are Self-jector (mfd. by Mitsubishi Kakoki Kaisha, Ltd) and the disc-type Centrifuge CHPX series (mfg. by Nagase-Alpha K.K).

The present invention is further illustrated by the following Examples which are illustrative only and not to be regarded as in any way limiting the present invention.

Example 1

300 kg of sardine pieces (15 mm) and 15 g of Protease Amano A (mfd. by Amano Pharmaceutical Co., Ltd.), which had been preliminarily dissolved in 1 ℓ of water, were introduced into a 500-ℓ kneader-type reactor. The resulting mixture was heated to 50 to 55 °C and maintained at this temperature for 20 minutes under stirring. Then it was further heated to 70 to 75 °C and maintained at this temperature for 20 minutes to thereby inactivate the enzyme. The slurry thus obtained was fed into a continuous three-phase decanter to thereby divide the same into a cake, a heavy liquor and a light liquor. The ratio by weight of the cake, heavy liquor and light liquor thus obtained was 45 : 40 : 15. The moisture content of the heavy liquor was 80 % by weight. This heavy liquor was concentrated in a concentrating drum to give a moisture content of 70 % and then combined with the abovementioned cake. The mixture thus obtained was fed into a dryer and dried therein at 70 to 75 °C. Thus 65.1 kg of a fish meal of a moisture content of 8.0 % was obtained. The yield of the fish meal based on the starting fish was 21.7 %, which was comparable to those achieved by conventional methods.

Table 1-a shows the analytical data of the fish meal thus obtained as well as that of a conventional one for reference.

Table 1-a

	Fish meal produced by the invention process (%)	Reference (%)
Moisture	8.0	7.8
Crude protein	68.2	68.3
Crude fat	9.8	9.6
Ash	14.0	14.3

Separately the light liquor as obtained above was continuously centrifuged to thereby separate an oil. Thus 25.2 kg of a fish oil was obtained. The yield of the fish oil based on the starting fish was 8.5 %, which was comparable to those achieved by conventional methods, taking the crude fat content of the starting fish (12.0 %) and that contained in the fish meal into consideration.

Table 1-b shows the analytical data of the fish meal thus obtained as well as that of a conventional one for reference.

Table 1-b

	Fish oil produced by the invention process	Reference
AV (mg KOH/g)	2.3	5.0
IV	176.2	173.1
POV (meq/kg)	5	8

Example 2

The procedures of Example 1 were repeated except that a continuous reactor was employed. Namely, a horizontal reactor provided with a stirrer wherein fish bodies were stirred in the form of a piston flow was used. Further the reaction mixture was heated in a heating zone and the reaction time as defined in Example 1 was regarded as the residence time. The enzyme was dissolved in water and continuously added to the reactor at the same ratio as the one specified in Example 1.

Starting fishes comprising approximately 5 % of mackerels and the balance of sardines were cut into pieces of 25 mm and treated at a rate of 5 t/hr for 20 hours.

As a result, 22.0 t of a fish meal of a moisture content of 7.6 % and 10.0 t of a fish oil were obtained. The yields of these products based on the starting fishes were 22.0 % and 10.0 %, respectively, each comparable to those achieved by conventional methods. Table 2-a shows the analytical data of the fish meal thus obtained and those of a conventional one for reference.

Table 2-a

	Fish meal produced by the invention process (%)	Reference (%)
Moisture	7.6	7.8
Crude protein	68.4	68.3
Crude fat	10.0	9.6
Ash	14.0	14.3

Table 2-b shows the analytical data of the fish oil as obtained above and those of a conventional one for reference.

Table 2-b

	Fish oil produced by the invention process (%)	Reference (%)
AV (mg KOH/g)	2.5	5.0
IV	176.0	173.1
POV (meq/kg)	5	8

Example 3

4 t of sardines and 200 g of Protease Amano A (mfd. by Amano Pharmaceutical Co., Ltd.), which had been dissolved in a small amount of water, were introduced into a 5-m^3 reactor provided with a stirrer. The resulting mixture was heated to 50 to 55 °C and maintained at this temperature for 20 minutes under stirring. Then it was further heated to 70 to 75 °C and maintained at this temperature for 20 minutes to

thereby inactivate the enzyme. The slurry thus obtained was passed through a 10 mm-mesh sieve to thereby remove fish bones therefrom. After removing the fish bones, the slurry was fed into a continuous decanter and thus divided into solid and liquid matters. The solid matters were dried in a drier at 70 to 75°C to thereby give 660 kg of a fish meal. The yield of this fish meal based on the starting fish was 16.5 %.

Table 3 shows the analytical data of the fish meal thus obtained and those of a conventional one for reference.

Table 3

	Fish meal produced by the invention process (%)	Reference (%)
Moisture	7.9	7.8
Crude protein	73.1	68.3
Crude fat	8.9	9.6
Ash	10.1	14.3

Example 4

The procedures of Example 3 were repeated until the step of dividing the slurry into solid and liquid matters. Subsequently the liquid matters were continuously centrifuged to give stick water which was then concentrated at a temperature below 75°C to thereby give fish-solubles. The fish-solubles thus obtained were combined with the solid matters obtained above and dried in a drier at 70 to 75°C. Thus 720 kg of a fish meal was obtained. The yield of the fish meal based on the starting fish was 18.0 %.

Table 4 shows the analytical data of the fish meal as obtained above and those of a conventional one for reference.

Table 4

	Fish meal produced by the invention process (%)	Reference (%)
Moisture	8.0	7.8
Crude protein	73.3	68.3
Crude fat	9.6	9.6
Ash	9.2	14.3

Claims

1. A process for producing fish meal and/or fish oil from fish bodies in which the fish bodies are treated to separate solid and liquid portions therefrom and the separated portions further treated to produce fish meal and/or fish oil, characterised in that the fish bodies are treated with a protease at a temperature at which the protease is active to form a slurry and the slurry is separated into solid and liquid fractions by means of a continuous decanter.

2. A process as claimed in claim 1 characterised in that the continuous decanter is a two-phase decanter which separates the slurry into a solid portion and a liquid portion.

3. A process as claimed in claim 2 characterised in that the slurry is first passed through a sieve to remove fish bones therefrom and then separated into a solid and a liquid portion by means of the continuous decanter.

4. A process as claimed in claim 2 or 3 characterised in that the separated solid portion is dried to produce a fish meal.

5. A process as claimed in any one of claims 2, 3 or 4 characterised in that the separated liquid portion is continuously centrifuged to separate stick water, the separated stick water is concentrated from fish solubles, the resulting fish solubles are mixed with the separated solid portion and the mixture of fish solubles and separated solid portion dried to form a fish meal.

6. A process as claimed in claim 1 characterised in that the continuous decanter is a three-phase decanter which separates the slurry into a cake, a heavy liquor and a light liquor.

7. A process as claimed in claim 6 characterised in that the separated heavy liquor is concentrated to produce a concentrate and the concentrate is mixed with the cake and the resulting mixture dried to form a fish meal.

8. A process as claimed in claim 6 or 7 characterised in that the separated light liquor is continuously centrifuged to separate a fish oil therefrom.

9. A process as claimed in any one of the preceding claims characterised in that after treatment with the protease but before separation of the slurry into solid and liquid fractions, the slurry is heated to a temperature and for a time which will deactivate the protease without causing any substantial denaturing of the protein content of the slurry.

10. A process as claimed in any one of the preceding claims characterised in that the protease is one which is active at a temperature within the range of from 30° C., to 80° C.

11. A process as claimed in any one of the preceding claims characterised in that the treatment with the protease is carried out with continuous agitation.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 30 6840

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
X	US-A-4 405 649 (G.A. JEFFREYS et al.) * claim 1 * ---	1	A 23 L 1/326 A 23 J 1/04 A 23 K 1/10
A	US-A-4 335 146 (P.V.H. BLADH) * claim 1 * ---	1,5	
A	PATENT ABSTRACTS OF JAPAN volume 9, no. 211 (C-300) (1934), 29th August 1985; & JP - A - 60 78548 (YASUZOU UCHIDA) 04-05-1985 -----	1,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.3)

A 23 L 1/00
A 23 J 1/00
A 23 K 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	24-10-1988	SCHULTZE D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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